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The mechanical superiority of the tritubercular type, over every other has been repeatedly demonstrated in its plastic capacity of adaptation to the most extreme trenchant and crushing functions.

THE ARTIODACTYLA.[1]

BY E. D. COPE.

THE Artiodactyla is the suborder of the Diplarthrous Ungulata in which the astragalus articulates with the second row of tarsal bones by a ginglymus or hinge, and in which the third and fourth toes are equally or subequally developed.[2] It includes the most highly modified of the Mammalia, whether we regard the organs of locomotion or of digestion. The antelope and deer illustrate the greatest speed to which the mammal has attained. Their extraordinary apparatus for the digestion of vegetable substances which contain but a small percentage of nutritious proteids, has given them an extraordinary advantage, so that they are after the rodents, the most abundant of their class, in spite of the persistent persecution of the carnivorous species. They attain in the genera Giraffa and Bos the largest dimensions in the class, excepting only the Proboscidia.

The Artiodactyla make their first appearance in the early or Wasatch Eocene in the genus Pantolestes Cope. A genus exists at a corresponding horizon in Europe. No other genus of the suborder appears with it. Its representatives steadily increase in numbers in the succeeding Bridger and Uinta epochs in America, and in the Calcaire grossier and Gypse of Europe. Some of these, *e.g.*, the Anoplotheriidæ of Europe, diverge from the line of succession, while others, *e.g.*, Xiphodontidæ, are clearly ancestors of later forms. In America, the Pantolestidæ appear as ancestors of the Camels especially. I now give a synopsis of the families of the suborder and their phylogenetic relations.

I. Superior molars tritubercular (Pantolestoïdea).

Molars bunodont; four digits.............................. *Pantolestidæ.*

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[1] Modified for the Naturalist from a paper by the author in the Proceeds. of Amer. Philos. Society, 1887, p. 377.

[2] See Naturalist, November, 1877.

II. Superior molars quadritubercular with an intermediate fifth.

1. Three digits (Anoplotheroïdea).

Intermediate tubercle anterior.......................... *Anoplotheriidæ.*

11. Two or four digits (Anthracotheroïdea).

A. The intermediate tubercle posterior.

Four digits; molars bunodont................................ *Dichobunidæ.*

Four digits; molars selenodont.......................... *Cœnotheriidæ.*

AA. The intermediate tubercle anterior.

Four digits; one series of V's below............... *Anthracotheriidæ.*

Two or four digits; two series of V's below......... *Xiphodontidæ.*

III. Superior molars quadritubercular, without an intermediate fifth.

A. Molars bunodont, or cross-crested, (Suoïdea).

Mandibular condyle triangular; no postglenoid process...... *Suidæ.*

Mandibular condyle subcylindric; a postglenoid process.. *Hippopotamidæ.*

AA. Molars selenodont (with four crescents above).

a. Inferior molars with one series of crescents (Merycopotamoïdea).

Premolars unlike molars........................... *Merycopotamidæ.*

aa. Inferior molars with two series of crescents.

β. Superior premolars (except first premolar) with one crest (Cameloïdea).

γ. "Fourth premolar like molars below, with three crests above."

Two digits only (four? in Agriochœrus)............... *Dichodontidæ.*

γγ. Fourth premolar entirely different from molars.

δ. Navicular and cuboid bones distinct from each other.

ε. Superior incisors present.

No cannon bone; a vertebrarterial canal............... *Oreodontidæ.*

No vertebrarterial canal; no cannon bone......... *Poëbrotheriidæ.*

No vertebrarterial canal; a cannon bone;........... *Protolabididæ.*

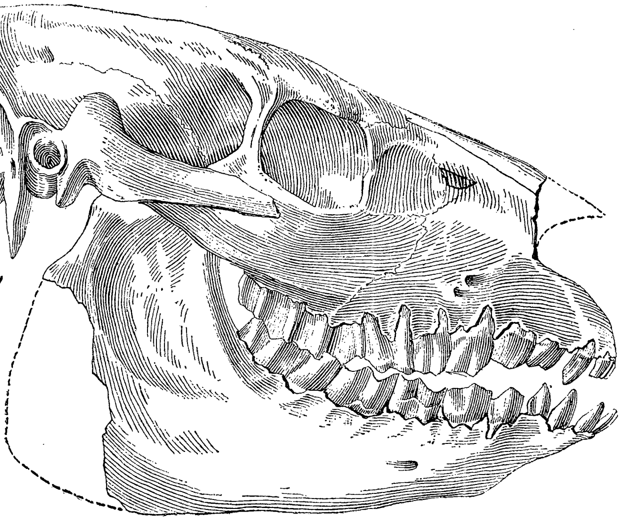
εε. No superior incisors (except incisor three).

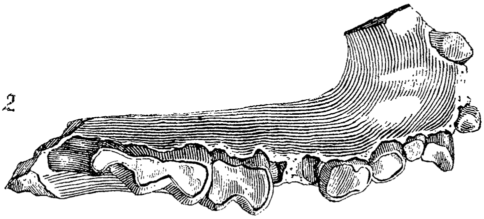
No vertebrarterial canal; a cannon bone; superior p. m. iv with external and internal crests............................ *Camelidæ.*

Like Camelidæ, but superior p. m. iv a simple cone ... *Eschatiidæ.*

δδ. Navicular and cuboid bones coössified.

PLATE XXVII.





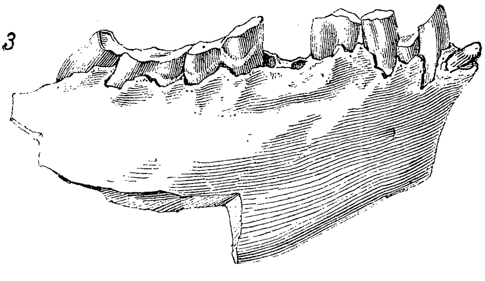


Fig. 1.—*Merychyus arenarum* Cope. $\frac{9}{16}$ 2-3. *Pithecistes facies* Cope.

All premolars but No. iv without internal crescent ...... *Tragulidæ.*

ββ. Superior premolars 2-3-4 with internal as well as external crest; a naviculocuboid bone; no superior incisors (Boöidea).

Superior p. m. ii without internal crescent......................*Moschidæ.*
Superior p. m. ii with internal crescent.
Horns permanent, originating distinct from skull......... *Giraffidæ.*
Horns permanent, processes of the skull ....*Movidæ.*
Horns periodically shed ....*Cervidæ.*

Of the preceding sixteen families, ten are extinct. The six families with living representatives are the Suidæ, the Tragulidæ, the Camelidæ, the Moschidæ, the Cervidæ, the Giraffidæ, and the Bovidæ.[1] Thus none of the primary divisions, I and II, have recent representatives. But few of them in fact (some Cænotheriidæ and Anthracotheriidæ) survived the Eocene epoch. Division III is, on the other hand, characteristic of Miocene and recent time, except that some specimens of Gelocus of the Tragulidæ have been found in Upper Eocene beds. Several genera of Tragulidæ, with Elotherium and Poëbrotherium and Oreodon, belong to Oligocene beds.

Tubercular or bunodont molars are of prior age to selenodont molars, phylogenetically speaking. Of the former, the tritubercular type, it has been already shown, is ancestral to the quadritubercular type. Pantolestidæ are then clearly ancestral to all known Artiodactyla, and are themselves probably the descendants of the lost Amblypoda Hyodonta, whose existence I have anticipated on hypothetical grounds. Of the remaining families which are constructed on the quadritubercular basis, there are two types, as represented in divisions II and III of the preceding table. The intermediate or fifth lobe is especially characteristic of Eocene Artiodactyla. The intermediate tubercles exist in the Pantolestidæ, and one of them is preserved in the families of division II; but in group *A* it is the posterior one, and in group *AA* it is the anterior one. In the Suidæ and Hippopotamidæ, which are permanently bunodont, the intermediates are either lost or so divided as to lose their distinctive character. In Elotherium traces of both the intermediates are visible, but they are obscure. The genetic relations of the families with five lobes to those with four are supposed by Schlosser to be direct and ancestral. This looks probable in the case of the Merycopotamidæ of the latter group, which has inferior molars like those of Hyopotamus of the former group. Whether the remaining families of division III *AA* (see table) (four-lobed) came off from the families of division II (five-lobed) is uncertain. It is probable that the fifth and sixth (or intermediate) tubercles were present in all primitive Artiodactyla, but they may have been lost, as in the Suidæ, in the bunodont stage, which gave origin to III *AA*, so as to be wanting from the earliest four-lobed selenodont ancestors. Of the two types of II (Anthracotheroïdea) the division *A* is supposed by Schlosser to have been the ancestor of the true selenodonts (III *AA*), but excepting in the case of Merycopotamidæ, this has not yet been demonstrated. Scott suspects with reason that the quinquetubercular Protoreodon is the ancestor of the quadritubercular Oreodon.

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[1] Antilocapra is sometimes separated from the Bovidæ as the type of a family, because it is said to sometimes shed its horny horn-sheath. This character, were it really normal, has no significance sufficient for the establishment of a family division.

Leaving this debatable question, I refer to the family of the Anoplotheriidæ. The remarkable structure of the feet discovered by Gervais, and shown by Schlosser to belong to this family distinguishes it at once from all families of this and all other orders.

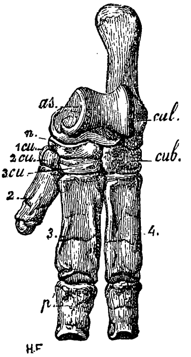

FIG. 1.—Right posterior foot of *Anoplotherium latipes* Gerv. $\frac{1}{6}$ nat. size. *Cal.*, Calcaneum; *As.*, astragalus; *Cub.*, cuboid; *Cu.*, cunei forms.—From the Eocene of Debruge; from Gaudry, Enchainment du Monde Animal.

The second digit is well developed in both feet, and stands inwards at a strong angle to the other toes. A rudimental fifth is present in the manus, but not in the pes. The latter is therefore tridactyle. The third and fourth digits are equal in the pes, but the third exceeds the fourth in the manus, giving an entirely perissodactyle character. Some didactyle forms have been placed in this family, but this is inadmissible on ordinary taxonomic principles. The divergent inner toe is supposed to have supported a web, useful in an aquatic life. As remarked by Schlosser, the origin of the Anoplotheridæ is entirely obscure as yet, the only ancestor yet known being the Pantolestidæ. It is probable that some unknown member of the Anthracotheroidea, which had bunodont teeth, may form one of the missing links. Cebochœrus offers the proper type of dentition, and the number of toes (four, Schlosser) is also appropriate, but whether there are any structural obstacles to its being ancestral to the Anoplotheriidæ I do not know.

Anthracotheriidæ can be properly supposed to have descended from a type of Pantolestidæ with well-developed lateral toes, by the addition of the fourth tubercle, and the loss of the posterior intermediate; while the Dichobunidæ have had the same origin, the posterior intermediate cusp being preserved. The Xiphodontidæ may be supposed to have come off from the Anthracotheriidæ by the usual process of diminishing the lateral digits and developing both sets of crescents in both superior and inferior molars. This family carried the specialization of the five tubercled type farther than any other.

The Suoïdea have come off from the Pantolestoïdea by the addition of the fourth (posterior internal) tubercle to the superior molars. Some genus with better developed lateral (second and fifth) digits than Pantolestes must have been the ancestor. Such a form will be discovered. It has been already anticipated by Schlosser.[1]

It is a circumstance confirmatory of the view that the Cameloïdea and Booïdea are descendants of the Anthracotheroïdea rather than of the Suoïdea, that no genus of the latter superfamily shows the least tendency to assume a selenodont structure of the molars. It is therefore not unlikely that the two groups named may have had the history of the Merycopotamoïdea already referred to. They did not probably come from the Merycopotamoïdea themselves, since the geological age of the latter is too late. Of course, however, members of this group may be yet discovered in earlier formations.

The problems of the phylogeny of the remaining groups are less difficult, and have been largely solved by the investigations of Kowalevsky and Schlosser. Tragulidæ have been derived from Oreodontidæ with simpler premolar teeth than the typical forms, (*e.g.*, Dorcatherium and Lophiomeryx). In turn they have given origin to primitive Bovidæ (Cosoryx) through Gelocus, which have then branched off into specialized Bovidæ on the one hand, and

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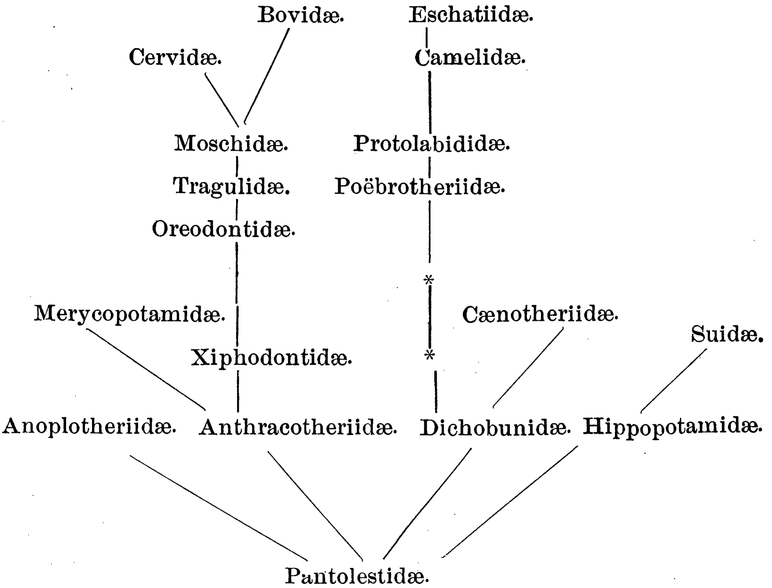
[1] Morphologisches Jahrbuch, 1886, p. 77.

Cervidæ on the other. The Poëbrotheriidæ have originated, from some family with diminished lateral digits, perhaps the Dichobunidæ, various intermediate genera being yet unknown. They are the direct ancestors of the Protolabididæ, the camels, and the Eschatiidæ. These relations may be expressed in the following table:—

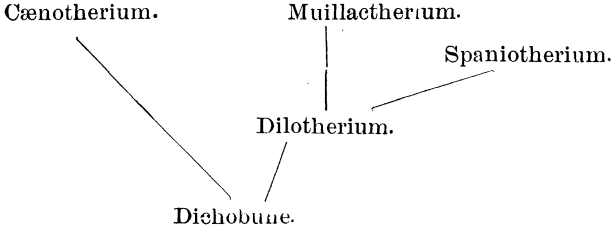


Of PANTOLESTIDÆ but one genus is known. The premolars are all simple in the upper jaw, except the fourth, which has one external and one internal tubercle. Six species are known from the Bridger and Wasatch Eocines of N. America. (FIG. 2.)

The structure of the premolars in Anoplotherium is complex for so primitive a type, and the third superior has an internal crest as well developed as in some of the Booïdæ. To the ANOPLOTHERIIDÆ are referred, besides Anoplotherium, Diplobune of Fraas and Dacrytherium, Mixtotherium and Mixochœrus of Filhol. But the structure of the feet of the latter genera is unknown. In Mixtotherium the fourth premolar is more, and the others less complex than in Anoplotherium. (FIGS. 1, 3.)

The known genera of DICHOBUNIDÆ are Dichobune of Cuvier, with Spaniotherium and Dilotherium of Filhol, in which the intermediate tubercles are less developed than in Dichobune. They are related to the twe selenodont genera of CÆNOTHERIIDÆ, Cænotherium and Muillactherium. The latter differs from the former in the absence of the intermediate crescent from the last superior molars. The species of Cænotherium differ in the absence or presence of a short diastema in the dental series, and in its position in the lower jaw, whether behind the first or secondpremolar. (FIG. 4.)

The Dichobunid bunodont genera are ancestral to the Cænotheriid selenodont genera in the following fashion :—



This family terminated with the selenodont genera, which, as Schlosser remarks, left no known descendants.

THE ANTHRACOTHERIIDÆ present but few varations. Four genera are known, which differ as follows :—

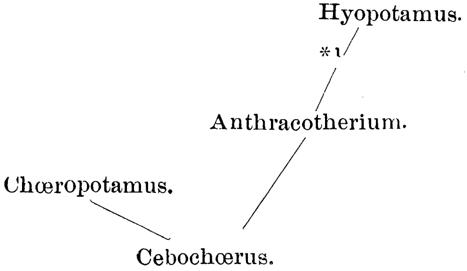
Entirely bunodont; no diastemata; canines developed. *Cebochœrus* Gerv.

Cusps of superior molars little flattened; diastemata; canine large. *Chœropotamus* Cuv.

Cusps of superior molars flattened; no diastemata; canines large. *Anthracotherium* Cuv.

Cusps of superior molars crescentoid in section; diastemata; canines large in males.............................. *Hyopotamus* Owen.

The three genera last named cannot, as Schlosser remarks, be related in direct lines, but through common ancestors; as may be shown thus :—



All the known species of this family are Old World excepting the single *Hyopotamus americanus* of Leidy. The genera Cebochœrus and Chœropotamus are from the Eocene, while the remaining two genera are of Miocene age. Some of the Anthracotheriums equaled the Rhinoceros in size, and were powerful beasts, well armed with formidable canine teeth. The species of Hyopotamus were on the other hand, of inoffensive character and had narrow compressed muzzles like the lamas, but more generally elongate.

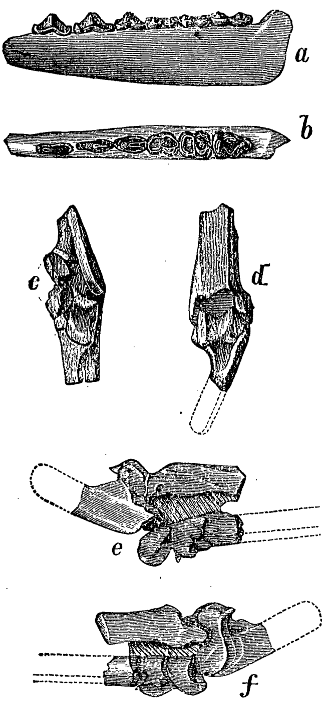


FIG. 2. — *Pantolestes brachystomus* Cope. Nat. size. From the Wasatch Eocene of Wyoming, N. A. Figs. *a*, *b*, mandibular ramus with teeth; *c*. *f*. tarsus, and parts of tibia and metatarsus.

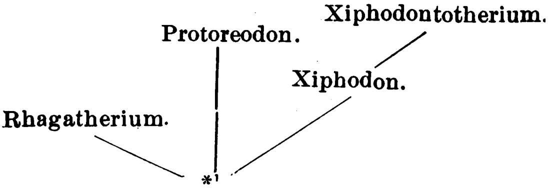
The ancestral genus is bunodont, without diastemata, and with well-developed canines. The hypothetical genus (1) is selenodont, with short diastema, and well-developed canines.

The certainly known genera of the XIPHODONTIDÆ are four, which differ as follows:—

Molars bunodont; diastemata; canines large......*Rhagatherium* Pict.
Molars selenodont; diastemata; canines medium.........................*Xiphodontotherium* Filh.
Molars selenodont; no diastemata; canines not distinct in form.........*Xiphodon* Cuv.
Molars selenodont; no diastemata; superior canine developed; inferior p. m. 4 functioning as canine. *Protoreodon* S. and O.

Cryptomeryx Schl. probably belongs here.

The relations of these genera are clearly somewhat like those of the preceding family. The bunodont condition of the molars of Rhagatherium is primitive, while its diastemata are the reverse: The continuous dental series of Xiphodon is primitive, while the detailed structure of the molars is advanced. These relations may be thus shown:—



The hypothetical genus 1 is simply a bunodont without diastemata, and with well-developed canines.

The genera of this family are Old World, except Protoreodon, which is North American. The *Xiphodon gracilis* Cuv. is one of the most abundant species of the Gypse of Paris and its equivalents. The restoration of Cuvier shows it to have been a graceful animal, with slender legs and neck. In Prootreodon S. and O. we first see the enlargement of the fourth inferior premolar (first olim) to function as a canine, which afterwards became such an important character of the Oreodontidæ. Probably two species are known, both from the Uinta formation of Utah; the type, *P. pavous* Scott and Osborn, being about the size of a raccoon.

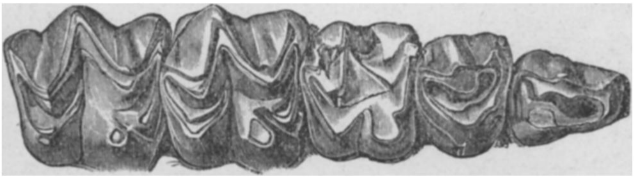


FIG. 3.—*Anoplotherium caylusense.* Lyd part of right maxilla with molars, from Upper Eocene of Claylux France. Nat. size. From Lydekker.

The Hippopotamidæ embraces a considerable variety of genera, which are spmetimes arranged in separate families. They are as follows:—

I. Digits four.

A. Metapodials distinct, distally keeled behind only; inferior incisors straight, subcylindric (Hippopotaminæ).

Six lower incisors; orbit closed............*Hexaprotodon* Caut. Falc.
Four lower incisors; orbit closed..............*Hippopotamus* Linn.
Two lower incisors; orbit not closed.................*Chœropsis* Leidy.

AA. Metapodials distinct; inferior incisors normal (Hyotheriinæ).

Canines small, the inferior not received into a notch of the upper jaw; premolars $\frac{4}{4}$; fourth with two external tubercles;
Hyotherium von. M.

Canines large, the inferior received into a deep excavation in front of the superior canine; premolars $\frac{4}{4}$; fourth with one lubercle; *Bothrolabis* Cope.

Like Bothrolabis, but premolars $\frac{3}{3}$.............. *Chœnohyus* Cope

II. Digits three.

I. Metapodials fused proximally (Dicotylinæ).

a. Premolars like molars; a deep notch in front of superior canine.

Premolars $\frac{3}{3}$; cusps of molars separate.................. *Dicotyles* Cuv.

Premolars $\frac{3}{3}$; cusps of molars united into partial cross-crests *Platygonus* Lec.

III. Digits two (Elotheriinæ).

Superior canines decurved; last inferior molar without heel; *Elotherium* Pom.

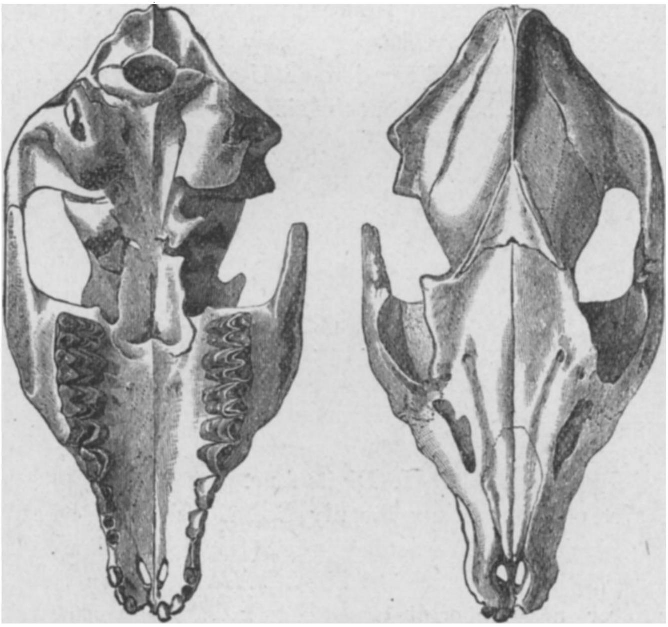
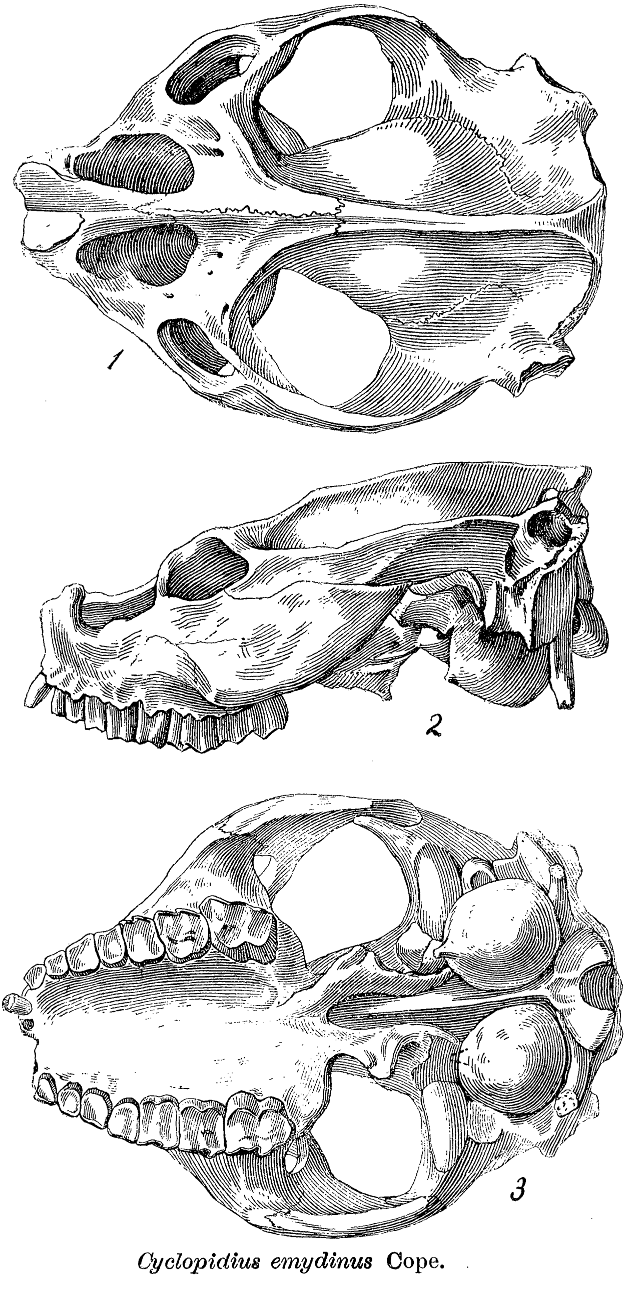


FIG. 4.—*Cœnotherium filholi* Lydekker, superior and inferior views of skull, from the Eocene of Caylux, France. Natural size. From Lydekker,

The genera of Hippopotaminæ are all Old World. While a single living species represents each of the genera Hippopotamus and Chœropsis, there are several extinct species of Hippopotamus and Hexaprotodon. These are chiefly confined to the Upper Miocene

PLATE XXVIII.



Cyclopidius emydinus Cope.

of India, but a species has been found in Algerian deposits, and a large form, *Hippopotamus major*, is abundant in the Plistocene of Southern Europe. Of the Hyotheriinæ the most generalized form, Hyotherium, is represented by several species in Europe and India. In its characters it is the most primitive of the family excepting in the weakness of the canine teeth. It is nearer the ancestral genus of the family than any that is yet known. In Bothrolabis we have a distinct approach to Dicotyles, of which it is probably the ancestor. Four species from the John Day or Middle Miocene of Oregon are known. They were of the sizes of the existing peccaries. The genus Platygonus embraces extinct species of North America and Mexico. *P. vetus* Leidy has left remains in the Pennsylvania Bone Caves. It was larger than the white-lipped peccary. *P. alemani* Dugés has been found in Mexico.

Several extinct species of Dicotyles are known, from the North American Plistocene and ? Pliocene. One of them, *D. nasutus* Leidy, has a more elongate muzzle than any of the recent species.

The Elotheriinæ embrace the oldest known forms of the family, dating in geological time from the Lower Miocene or Oligocene, and terminating with the summit of the middle Miocene. But one genus is certainly referable here, the Elotherium of Pomel; but a second, Tetraconodon Falconer, may belong in the same group. As the feet of the latter are unknown, the affinities cannot be yet determined. It differs in the inferior dentition from Elotherium by the huge size of its premolar teeth. Elotherium is represented by species over the Northern Hemisphere. The *E. magnum* is the only one known from Europe. It was larger than the domestic hog. The *E. mortoni* Leidy of North America was about the size of that animal. Its remains are common in the beds of White River age. It was accompanied by a huge species, the *E. ramosum* Cope, which has a skull as large as the Indian Rhinoceros. In all the species of this genus the mandibular ramus has two osseous projections, one opposite the symphysis, and the other well behind it. These are represented by wattles in old males of the recent hog. In the *E. ramosum* these tuberosities become processes, and the anterior ones especially are so long that when the chin was stretched, hog-like on the mud, it was raised well above the surface, allowing the passage underneath of water or of small animals. In the John

Day beds of Oregon another species of this genus is found, the *E. imperator* of Leidy, which was little inferior in dimensions to the *E. ramosum.* The greater part of its skeleton is known.

The pigs (SUIDÆ) are modified and specialized descendants of some form allied to Palæochœrus. Chronologically speaking they are of rather modern origin. The genera are as follows: —

(*a*) Molars and superior incisors not reduced; the former not covered with cement; superior canines recurved (Suinæ).

Molars with cusps united into transverse crests, *Listriodon* Meyer.

Molars with four much plicate tubercles on each.. *Hippohyus* Cautl. Falc.

Molars with numerous irregular accessory lobes; premolars $\frac{4}{4}$ .... *Sus* Linn.

No accessory lobes; premolars $\frac{2}{2}$.................*Babirussa* Cuv.

(*aa*) Superior incisors reduced in number; molars reduced in number, and the valleys filled with cement (Phacochœrinæ).

Superior incisors one; premolars none; molars $\frac{2}{2}$, with numerous tubercles; superior canines recurved..............*Phacochœrus* Cuv.

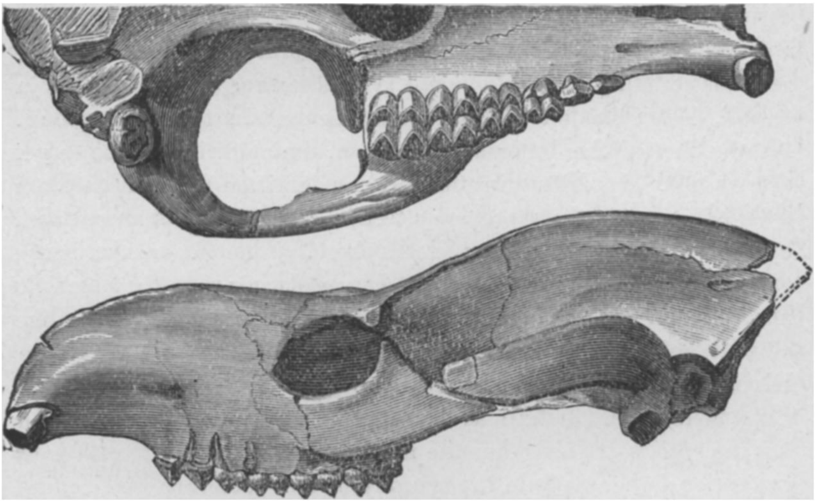
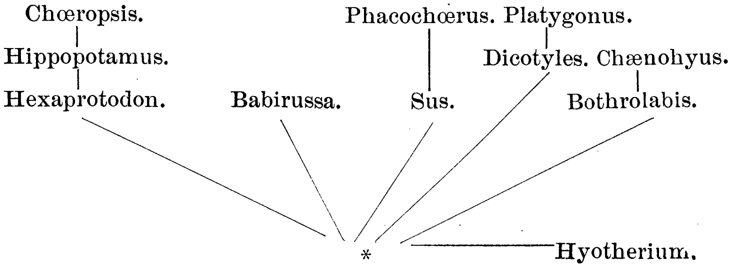


FIG. 5.—*Coloreodon ferox* Cope, skull from the John Day Miocene of Oregon, one-half natural size.

Listriodon and Hippohyus are the only genera of Suidæ which are extinct; but the extinct species of Sus are more numerous. In Listriodon the molar teeth are so tapir-like as to have led to its being placed in the Perissodactyla. When the skeleton was obtained, it was found to be artiodactyle, as suspected by Kowalevsky. One species, *L. splendens*, has been found in the Middle Miocene of Western Europe. Hippohyus C. and F. is known from the Indian Siwaliks. A genus of probable affinities to it, founded on teeth only from Asiatic localities, is the Sanitherium of Schlagintweit. Some of the extinct species of Sus were of larger size than the existing hog, as the *S. giganteus* of the French Miocene, and the *S. erymanthius* of Pikermi, Greece. The *S. silvanius* Hodgson, a recent Indian species, is not larger than a small dog.

The phylogeny of these two bunodont families is nearly as follows, although the absence of intermediate types renders the final determination as yet impracticable. The main features may be however foreshadowed. The most generalized form is Palæochœrus, since its dentition is in all respects the most simple, while it preserves the full number of teeth. An unknown form resembling it, but with well-developed canine teeth, may have readily given origin to the Dicotyline line on the one side, and Sus and its immediate allies on the other. Babirussa is another derivative from the same centre. Phacochœrus may have come from some ally of Sus, since it carries to a great extreme the peculiarities of the latter genus. The ancestry of Hippopotamus is less easily determined. Its imperfect distal metapodial keels, which only exist on the posterior face of the condyle, bespeak for it an ancient ancestor. Its molar type is merely a complication of the quadritubercular, while the characters of its canines are an exaggeration of those of the primitive forms already mentioned. Several other genera, as Dicotyles and Sus, display the decumbent incisors which prepare the way for the remarkable straight digging incisors of Hippopotamus. The genus Hexaprotodon eases the passage backwards. These relations may be expressed as follows:—



The MERYCOPOTAMIDÆ embrace but one genus, Merycopotamus C. and F., which is a form of considerable interest. Its superior molars display the simple quadriselenodont type of the later families, but in the lower jaw the primitive condition of but one series of crescents still remains. Several species are known, all from the upper miocene of India.

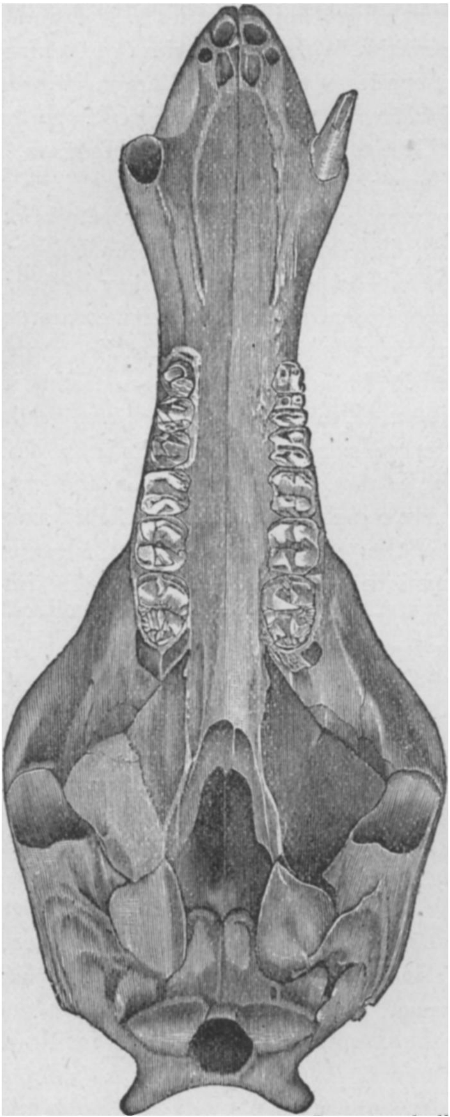


FIG. 6.—*Platygonus compressus* Leconte; skull from below, ⅗ nat. size. From Kentucky.

The OREODONTIDÆ is the prevalent type of Artiodactyla during Miocene time in North America. Their characters are as follows:—

Dentition: superior incisors present; molars selenodont. Cervicals with the transverse processes perforated by the vertebrarterial canal. No alisphenoid canal. Ulna and radius, and tibia and fibula distinct. Metapodial bones four on each foot, with incomplete distal trochlear keels. Lunar bone not supported by magnum Navicular and cuboid bones distinct.

The details of the structrue express various affinities. The axis is intermediate between that of the suilline and ruminant Artiodactyla; the other cervicals are suilline, while the remaining vertebræ are ruminant. The scapula is ruminant, not suilline; while the humerus is like Anoplotherium. The radiocarpal articulation is intermediate between that of hogs and ruminants. The unciform supports the lunar bone. The sacrum is ruminant, the ilium suilline. The femur and tarsus are much like those of the peccary.

The known genera of this family are the following:—

A. Orbit complete; premolars four, the fourth with one external crescent. First premolar below functioning as canine.

a. No facial vacuities.

Premaxillaries distinct; otic bullæ not inflated; five digits in manus..*Oreodon* Leidy.

Premaxillaries distinct; otic bullæ inflated; four digits in manus...*Eucrotaphus* Leidy.

Premaxillaries coössified; otic bullæ inflated...*Merycochœrus* Leidy.

aa. Facial vacuities present.

Premaxillaries coössified, dentigerous; vacuities prelachrymal only..*Merychyus* Leidy.

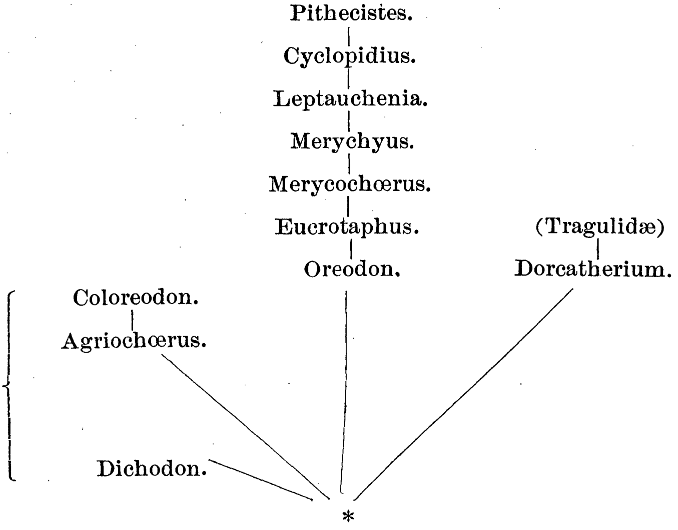
Incisors six above, persistent; vacuities prelachrymal and prefrontal; nasal bones much reduced.....*Leptauchenia* Leidy.

Incisors very few, caducous; vacuities as in Letanc phenia, very large...*Cyclopidius* Cope.

AA. Inferior premolars three. True inferior canine functional.

Inferior incisors one on each side...........*Pithecistes* Cope.

Starting from Oreodon as the ancestral form, Eucrotaphus follows at a little distance. The presence of the pollex observed by Scott in Oreodon proves that it must be referred to a five-toed common ancestor with Dorcatherium. The enlarged bullæ are added in Eucrotaphus, and the coössified premaxillaries in Merycochœrus and Merychyus. The latter commences the facial vacuities, which reach such huge proportions in Leptauchenia and Cyclopidius. The loss of the incisor teeth from both jaws, and diminished size, indicate that decadence is going on in Cyclopidius, but the last term is reached in Pithecistes. Here not only incisors but a premolar disappears. This family, once powerful in numbers, size and strength, disappeared with the Upper Miocene period in North America. These relations may be thus displayed. A common ancestor with Dorcatherium is assumed. This will be a genus like Protoreodon S. and O., but without the caniniform inferior p. m. i of that genus, and probably with the fifth crescent of the superior molars. Agriochœrus may have been derived from the same.



The genealogical positions of these genera are as follows:

Oreodontinæ.	No. of Species	White River Epoch	John Day Epoch	Ticho-leptus Epoch	Loup Fork Epoch
Oreodon Leidy	3	——			
Eucrotaphus Leidy	3	——	——		
Merycochœrus Leidy	8	——	——	——	——
Merychyus Leidy	6			——	——
Leptauchenia Leidy	3			——	
Cyclopidius Cope	2			——	
Pithecistes Cope	3			——	

The numbers of individuals of Oreodontidæ which must have existed during the Miocene period in North America is so great as to astonish the palæontologist. During the White River epoch droves of *Oreodon culbertsoni* inhabited the swamps, and the small *O. minor* was abundant. Several forms, perhaps species, coexisted with these two. During the John Day epoch Oregon and adjacent regions were overrun by the *Eucrotaphus pacificus*, and the large and formidable *Merycochoerus superbus* (Plate XXVI). At a still later date, in the Ticholeptus epoch, the species of Cyclopidius were scarcely less abundant. All of these forms were the prey of numerous Carnivora, mostly false sabre-tooth or half sabre-tooth cats, of the family of the Nimravidæ. The large Merycochœri possessed the means of making a formidable defense, but the Merychyi of later age were of decidedly less vigorous mould (Plate XXVII). The species of Leptauchenia and Cyclopidius were probably aquatic in their habits. The species of the last named genus (Plate XXVIII.) had produced tympanic bones like the hippopotamus for the insertion of ears that projected above the water, while the eyes are partly vertical to permit of vision without much exposure of the head. The nostrils are at the extremity of a sharp muzzle like the snapping tortoise to premit of breathing without exposure of the face. The object of the remarkable facial vacuities in this genus and Leptauchenia is unknown. It may have permitted the attachment of an inflatable integument like the nasal hood of the hooded seal. In Pithecistes the incisor teeth have disappeared, and the short deep jaw, the only part which is known, resembles in its coössified symphysis, that of a monkey.

(To be continued.)